Claims

1. A method of designing a multifocal ophthalmic lens with one base focus and at least one additional focus, capable of reducing aberrations of the eye for at least one of the foci after its implantation, comprising the steps of:

   (i) characterizing at least one corneal surface as a mathematical model;

   (ii) calculating the resulting aberrations of said corneal surface(s) by employing said mathematical model;

   (iii) modelling the multifocal ophthalmic lens such that a wavefront arriving from an optical system comprising said lens and said at least one corneal surface obtains reduced aberrations for at least one of the foci.

2. A method according to claim 1, wherein the ophthalmic lens is a multifocal intraocular lens.

3. A method according to claim 1 or 2, comprising determining the resulting aberrations of said corneal surface(s) in terms of a wavefront having passed said cornea.

4. A method according to any of the claims 1 to 3, wherein said corneal surface(s) is(are) characterized in terms of a conoid of rotation.

5. A method according to any of the claims 1 to 3 wherein said corneal surface(s) is(are) characterized in terms of polynomials.

6. A method according to claim 5, wherein said corneal surface(s) is(are) characterized in terms of a linear combination of polynomials.

7. A method according to any of the preceding claims, wherein said optical system, further comprises complementary means for optical correction, such as spectacles or

an ophthalmic correction lens.

8. A method according to any of the preceding claims, wherein estimations of corneal refractive power and axial eye length designate the selection of the optical powers for the multifocal intraocular lens.

9. A method according to any of the preceding claims, wherein the multifocal intraocular lens is modelled by selecting a suitable aspheric component for the anterior surface.

10. A method according to any of the preceding claims, including characterizing the front corneal surface of an individual by means of topographical measurements and expressing the corneal aberrations as a combination of polynomials.

11. A method according to any of the preceding claims, including characterizing front and rear corneal surfaces of an individual by means of topographical measurements and expressing the total corneal aberrations as a combination of polynomials.

12. A method according to any of the preceding claims, including characterizing corneal surfaces of a selected population and expressing average corneal aberrations of said population as a combination of polynomials.

13. A method according to any of the preceding claims, comprising the further steps of :

(vii) calculating the aberrations resulting from an optical system comprising said modelled intraocular lens and cornea;
(iix) determining if the modelled intraocular lens has provided sufficient reduction in aberrations; and optionally re-modelling the intraocular lens until a sufficient reduction is obtained.

14. A method according to claim 13, wherein said aberrations are expressed as a linear combination of polynomials.

15. A method according to claim 13 or 14, wherein the re-modelling includes modifying one or several of the anterior surface shape and central radius, the posterior surface shape and central radius, lens thickness and refractive index of the lens.

16. A method according to any of the claims 14 to 15, wherein the re-modelling includes modifying the anterior surface of the lens.

17. A method according to any of the claims 14 to 16, wherein said polynomials are Seidel or Zernike polynomials.

18. A method according to claim 17, comprising modelling a lens such that an optical system comprising said model of intraocular lens and cornea provides reduction of spherical terms as expressed in Seidel or Zernike polynomials in a wave front having passed through the system.

19. A method according to claim 17 or 18, comprising the steps of:

expressing the corneal aberrations as a linear combination of Zernike polynomials;

determining the corneal wavefront Zernike coefficients;

modelling the multifocal intraocular lens such that an optical system comprising said model lens and cornea provides a wavefront having a sufficient reduction of Zernike coefficients in at least 1 of the foci.

20. A method according to claim 19, further comprising the steps of :

calculating the Zernike coefficients of a wavefront resulting from an optical system comprising the modelled multifocal intraocular lens and cornea;

determining if said intraocular lens has provided a sufficient reduction of Zernike coefficients; and optionally re-modelling said lens until a sufficient reduction is said

coefficients are obtained.

21. A method according to claim 20, comprising sufficiently reducing Zernike coefficients referring to spherical aberration.

22. A method according to any of the claims 19 to 21 comprising sufficiently reducing Zernike coefficients referring to aberrations above the fourth order.

23. A method according to any of the claims 19 to 22 comprising sufficiently reducing the 11th Zernike coefficient of a wavefront front from an optical system comprising cornea and said modelled intraocular lens, so as to obtain an eye sufficiently free from spherical aberration.

24. A method according to any of the preceding claims, wherein the reduction of aberrations is optimized for one of the foci.

25. A method according to claim 24, wherein the reduction of aberrations is optimized for the base focus.

26. A method according to claim 24, wherein the reduction of aberrations is optimized for one of the at least one additional focus.

27. A method according to any of the claims 1 to 23, wherein the reduction of aberrations is optimized for the base focus and the at least one additional focus, simultaneously.

28. A method according to any of the preceding claims, wherein the modelling of the multifocal intraocular lens comprises modelling the lens as a multifocal lens of diffractive type.

29. A method according to claim 28, wherein the diffractive pattern is formed on the anterior and/or posterior surface of the lens.

30. A method according to claim 29, wherein the diffractive pattern is formed on the lens surface that is modelled to reduce aberrations of the optical system.

31. A method according to claim 29, wherein the diffractive pattern is formed on one surface of the lens and the other surface of the lens is modelled to reduce aberrations of the optical system.

32. A method according to any of the claims 1 to 28, wherein the modelling of the multifocal intraocular lens comprises modelling the lens as a multifocal lens of refractive type with annular rings with different radii of curvatures.

33. A method according to claim 32 wherein the annular rings are formed on the lens surface that is modelled to reduce aberrations of the optical system.

34. A method according to claim 32 wherein the annular rings are formed on one surface of the lens and the other surface is modelled to reduce aberrations of the optical system.

35. A method according to any of the claims 1 to 34, wherein the modelling of the multifocal intraocular lens comprises modelling a bifocal lens.

36. A method according to any of the claims 1 to 35, wherein the modeling of the multifocal intraocular lens provides a lens with substantially the same reduced aberrations for all foci.

37. A method according to any of the claims 1 to 36, wherein the sum of the modulation for the two or more foci is more than 0.40, at a spatial frequency of 50 cycles per millimetre, when the measurements are performed in an average/individual eye model using a 5mm aperture.

38. A method according to claim 37, wherein the sum of the modulation for the two or more foci is more than 0.50.

39. A method according to claim 37 or 38, wherein the modelling of the multifocal intraocular lens comprises modelling a bifocal lens with a light distribution of 50-50% between the two foci, and the modulation is at least 0.2 for each focus.

40. A method of selecting a multifocal intraocular lens that is capable of reducing aberrations of the eye for at least one of the foci after its implantation comprising the steps of:

(i) characterizing at least one corneal surface as a mathematical model;

(ii) calculating the resulting aberrations of said corneal surfaces(s) by employing said mathematical model;

(iii) selecting an intraocular lens having a suitable configuration of optical powers from a plurality of lenses having the same power configurations, but different aberrations;

(iv) determining if an optical system comprising said selected lens and corneal model sufficiently reduces the aberrations.

41. A method according to claim 40, comprising determining the resulting aberrations of said corneal surface(s) in a wavefront having passed said cornea.

42. A method according to claim 40 or 41 further comprising the steps of:

(v) calculating the aberrations of a wave front arriving from an optical system of said selected lens and corneal model;

(vi) determining if said selected multifocal intraocular lens has provided a sufficient

reduction in aberrations in a wavefront arriving from said optical system for at least one of the foci; and optionally repeating steps (iii) and (iv) by selecting at least one new lens having the same optical power until finding a lens capable of sufficiently reducing the aberrations.

43. A method according to any of the claims 40 to 42, wherein said corneal surface(s) is(are) characterized in terms of a conoid of rotation.

44. A method according to any of the claims 40 to 42 wherein said corneal surface(s) is(are) characterized in terms of polynomials.

45. A method according to any of the claims 40 to 42, wherein said corneal surface(s) is(are) characterized in terms of a linear combination of polynomials.

46. A method according to any of the claims 40 to 45, wherein said optical system further comprises complementary means for optical correction, such as spectacles or an ophthalmic correction lens.

47. A method according to any of the claims 40 to 46, wherein corneal refractive power and axial eye length estimations designate the selection of lens optical powers for the multifocal intraocular lens..

48. A method according to claim 39 or 45, wherein an optical system comprising said corneal model and selected multifocal intraocular lens provides for a wavefront substantially reduced from aberrations for at least one of the foci, as expressed by at least one of said polynomials.

49. A method according to any of the claims 40 to 48 including characterizing the front corneal surface of an individual by means of topographical measurements and expressing the corneal aberrations as a combination of polynomials.

50. A method according to any of the claims 40 to 49 including characterizing front and rear corneal surfaces of an individual by means of topographical measurements and expressing the total corneal aberrations as a combination of polynomials.

51. A method according to any of the claims 40 to 46, including characterizing corneal surfaces of a selected population and expressing average corneal aberrations of said population as a combination of polynomials.

52. A method according to claim 45 or 51, wherein said polynomials are Seidel or Zernike polynomials.

53. A method according to claim 52, comprising the steps of:

(i) expressing the corneal aberrations as a linear combination of Zernike polynomials;
(ii) determining the corneal Zernike coefficients;
(iii) selecting the multifocal intraocular lens such that an optical system comprising said lens and cornea provides a wavefront having a sufficient reduction in Zernike coefficients for at least one of the foci.

54. A method according to claim 53, further comprising the steps of :

(iv) calculating the Zernike coefficients resulting from an optical system comprising the modelled multifocal intraocular lens and cornea;
(v) determining if said intraocular lens has provided a reduction of Zernike coefficients; and optionally selecting a new lens until a sufficient reduction is said coefficients is obtained.

55. A method according to claim 53 or 54, comprising determining Zernike polynomials up to the 4^{th} order.

56. A method according to any of the claims 53 to 55 comprising sufficiently reducing Zernike coefficients referring to spherical aberration.

57. A method according to any of the claims 53 to 56 comprising sufficiently reducing Zernike coefficients above the fourth order.

58. A method according to any of the claims 53 to 57 comprising sufficiently reducing the 11th Zernike coefficient of a wavefront front from an optical system comprising model cornea and said selected intraocular lens, so as to obtain an eye sufficiently free from spherical aberration for at least one of the foci.

59. A method according to any of the claims 53 to 58 comprising selecting a intraocular lens such that an optical system comprising said intraocular lens and cornea provides reduction of spherical aberration terms as expressed in Seidel or Zernike polynomials in a wave front having passed through the system.

60. A method according to any of the claims 53 to 59, wherein reduction in higher aberration terms is accomplished.

61. A method according to any of the claims 40 to 60 characterized by selecting a multifocal intraocular lens from a kit comprising lenses with a suitable range of power configurations and within each range of power configurations a plurality of lenses having different aberrations.

62. A method according to claim 61, wherein said aberrations are spherical aberrations.

63. A method according to claim 62, wherein said lenses within each range of power configurations have surfaces with different aspheric components.

64. A method according to claim 63, wherein said surfaces are the anterior surfaces.

65. A method according to any of the claims 40 to 64, wherein the reduction of aberrations is optimized for one of the foci.

66. A method according to claim 65, wherein the reduction of aberrations is optimized for the base focus.

67. A method according to claim 65, wherein the reduction of aberrations is optimized for one of the at least one additional focus.

68. A method according to any of the claims 40 to 64, wherein the reduction of aberrations is optimized for the base focus and the at least one additional focus, simultaneously.

69. A method according to any of the claims 40 to 68, wherein the multifocal intraocular lens is a multifocal lens of diffractive type.

70. A method according to claim 69, wherein the diffractive pattern is formed on the anterior and/or posterior surface of the lens.

71. A method according to claim 70, wherein the diffractive pattern is formed on the lens surface that is modelled to reduce aberrations of the optical system.

72. A method according to claim 70, wherein the diffractive pattern is formed on one surface of the lens and the other surface of the lens is modelled to reduce aberrations of the optical system.

73. A method according to any of the claims 40 to 68, wherein the multifocal intraocular lens is a multifocal lens of refractive type with annular rings with different radii of curvatures.

74. A method according to claim 73 wherein the annular rings are formed on the lens surface that is modelled to reduce aberrations of the optical system.

75. A method according to claim 73 wherein the annular rings are formed on one surface of the lens and the other surface is modelled to reduce aberrations of the optical system.

76. A method according to any of the claims 40 to 75, wherein the multifocal intraocular lens is a bifocal lens.

77. A method according to any of the claims 40 to 35, wherein the multifocal intraocular lens has substantially the same reduced aberrations for all foci.

78. A method according to any of the claims 40 to 77, wherein the sum of the modulation for the two or more foci is more than 0.40, at a spatial frequency of 50 cycles per millimetre, when the measurements are performed in an average/individual eye model using a 5mm aperture.

79. A method according to claim 78, wherein the sum of the modulation for the two or more foci is more than 0.50.

80. A method according to claim 78 or 79, wherein the lens is bifocal with a light distribution of 50-50% between the two foci and the modulation is at least 0.2 for each focus.

81. A method of designing a multifocal ophthalmic lens suitable for implantation into the eye, characterized by the steps of:

selecting a representative group of patients;

collecting corneal topographic data for each subject in the group;

transferring said data to terms representing the corneal surface shape of each subject for a preset aperture size;

calculating a mean value of at least one corneal surface shape term of said group, so as to obtain at least one mean corneal surface shape term and/or calculating a mean value of at least one to the cornea corresponding corneal wavefront aberration term, each corneal wavefront aberration term being obtained by transforming corresponding through corneal surface shape terms;

from said at least one mean corneal surface shape term or from said at least one mean corneal wavefront aberration term designing a multifocal ophthalmic lens capable of reducing said at least one mean wavefront aberration term of the optical system comprising cornea and lens for at least one of the foci.

82. Method according to claim 81, characterized in that it further comprises the steps of:

designing an average corneal model for the group of people from the calculated at least one mean corneal surface shape term or from the at least one mean corneal wavefront aberration term;

checking that the designed multifocal ophthalmic lens compensates correctly for the at least one mean aberration term for at least one of the foci by measuring these specific aberration terms of a wavefront having travelled through the model average cornea and the lens and redesigning the multifocal lens if said at least one aberration term not has been sufficiently reduced in the measured wavefront.

83. Method according to claim 81 or 82, characterized by calculating an aspheric surface descriptive constant for the lens to be designed from the mean corneal surface shape terms or from the mean corneal wavefront aberration terms for a predetermined radius.

84. Method according to any one of the claims 81-83, characterized by selecting people in a specific age interval to constitute the group of people.

85. Method according to any one of the claims 81-84, characterized by selecting people who will undergo a cataract surgery to constitute the group of people.

86. Method according to any one of the claims 81-85, characterized by designing the lens specifically for a patient that has undergone corneal surgery and therefore selecting people who have undergone corneal surgery to constitute the group of people.

87. Method according to any one of the claims 81-86, characterized by selecting people who have a specific ocular disease to constitute the group of people.

88. Method according to any one of the claims 81-87, characterized by selecting people who have a specific ocular optical defect to constitute the group of people.

89. Method according to any one of the claims 81-88, characterized in that it further comprises the steps of:

measuring the at least one wavefront aberration term of one specific patient's cornea;

determining if the selected group corresponding to this patient is representative for this specific patient and if this is the case implant the multifocal lens designed from these average values and if this not is the case implant a multifocal lens designed from average values from another group or design an individual lens for this patient.

90. Method according to any one of the claims 81-89, characterized by providing the multifocal lens with at least one nonspherical surface that reduces at least one positive aberration term of an incoming nonspherical wavefront for at least one of the foci.

91. Method according to claim 90, characterized in that said positive aberration term is a positive spherical aberration term.

92. Method according to any one of the claims 81-91, characterized by providing the multifocal lens with at least one nonspherical surface that reduces at least one term of a Zernike polynomial representing the aberration of an incoming nonspherical wavefront for at least one of the foci.

93. Method according to claim 92, characterized by providing the lens with at least one nonspherical surface that reduces the 11th normalized Zernike term representing the spherical aberration of an incoming nonspherical wavefront.

94. A method according to any of claims 81-93 characterized by designing a multifocal lens to reduce, for at least one of the foci, spherical aberration in a wavefront arriving from an average corneal surface having the formula:

$$z = \frac{(1/R)r^2}{1+\sqrt{1-(\frac{1}{R})^2(\mathbf{cc}+1)r^2}} + \mathbf{ad}r^4 + \mathbf{ae}r^6$$

wherein the conical constant cc has a value ranging between –1 and 0, R is the central corneal radius and ad and ae are aspheric constants.

95. A method according to claim 94, wherein the conical constant (cc) ranges from about –0.05 for an aperture size (pupillary diameter) of 4 mm to about –0.18 for an aperture size of 7 mm.

96. Method according to claim 81-95, characterized by providing the multifocal lens with a surface described by a conoid of rotation modified conoid having a conical constant (cc) less than 0.

97. Method according to any one of the claims 81-96, characterized by providing the multifocal lens with a, for the patient, suitable power configuration,.

98. Method according to any one of the claims 81-97, characterized by designing the multifocal lens to balance, for at least one of the foci, the spherical aberration of a cornea that has a Zernike polynomial coefficient representing spherical aberration of the wavefront aberration with a value in the interval from 0.0000698 mm to 0.000871 mm for a 3 mm aperture radius.

99. Method according to any one of the claims 81-97, characterized by designing the multifocal lens to balance, for at least one of the foci, the spherical aberration of a cornea that has a Zernike polynomial coefficient representing spherical aberration of the wavefront aberration with a value in the interval from 0.0000161 mm to 0.000200 mm for a 2 mm aperture radius.

100. Method according to any one of the claims 81-97, characterized by designing the multifocal lens to balance, for at least one of the foci, the spherical aberration of a cornea that has a Zernike polynomial coefficient representing spherical aberration of the wavefront aberration with a value in the interval from 0.0000465 mm to 0.000419 mm for a 2,5 mm aperture radius.

101. Method according to any one of the claims 81-97, characterized by designing the multifocal lens to balance, for at least one of the foci, the spherical aberration of a cornea that has a Zernike polynomial coefficient representing spherical aberration of the wavefront aberration with a value in the interval from 0.0000868 mm to 0.00163 mm for a 3,5 mm aperture radius.

102. A multifocal ophthalmic lens obtained in accordance with any of the preceding claims, capable of, for at least one of its foci, transferring a wavefront having passed through the cornea of the eye into a substantially spherical wavefront having its centre in the retina of the eye.

103. A multifocal ophthalmic lens with one base focus and at least one additional focus, characterized in that the shape of the lens is modelled such that the resulting aberrations are reduced for at least one of the foci in an optical system comprising said

multifocal lens and a model cornea having aberration terms, or being without aberration terms.

104. A multifocal intraocular lens according to claim 103.

105. A multifocal intraocular lens according to claim 104 wherein said corneal model includes average aberration terms calculated from characterizing individual corneas for a suitable population, and expressing them in mathematical terms so as to obtain individual aberration terms.

106. A multifocal intraocular lens according to claim 105, wherein said aberration terms is a linear combination of Zernike polynomials.

107. A multifocal intraocular lens according to claim 106 capable of reducing aberration terms expressed in Zernike polynomials of said corneal model, such that a wavefront arriving from an optical system comprising said model cornea and said lens obtains substantially reduced spherical aberration.

108. A multifocal intraocular lens according to claim 107 capable of reducing the 11th Zernike term of the 4th order.

109. A multifocal intraocular lens according to any of the claims 103 to 108, adapted to replace the natural lens in a patient's eye, said multifocal intraocular lens having at least one nonspherical surface, this at least one nonspherical surface being designed such that the lens for at least one of the foci, in the context of the eye, provides to a passing wavefront at least one wavefront aberration term having substantially the same value but with opposite sign to a mean value of the same aberration term obtained from corneal measurements of a selected group of people, to which said patient is categorized, such that a wavefront arriving from the cornea of the patient's eye obtains a reduction in said at least one aberration term provided by the cornea after passing said lens.

110. A multifocal intraocular lens according to claim 109, characterized in that the nonspherical surface of the lens is designed to reduce at least one positive aberration term of a passing wavefront.

111. A multifocal intraocular lens according to claim 109 or 110, characterized in that the at least one wavefront aberration term provided to the passing wavefront by the lens is a spherical aberration term, such that a wavefront arriving from the cornea of the patient's eye obtains a reduction in said spherical aberration term provided by the cornea after passing said lens.

112. A multifocal intraocular lens according to any one of the claims 109 to 111, characterized in that the at least one wavefront aberration term provided to the passing wavefront by the lens is at least one term of a Zernike polynomial representing the wavefront aberration of the cornea.

113. A multifocal intraocular lens according to claim 112, characterized in that the at least one wavefront aberration term provided to the passing wavefront by the lens is the 11th normalized Zernike term of a wavefront aberration of the cornea.

114. A multifocal intraocular lens according to any one of the claims 105 - 113, characterized in that said selected group of people is a group of people belonging to a specific age interval.

115. A multifocal intraocular lens according to any one of the claims 105 - 114, characterized in that the lens is adapted to be used by a patient that has undergone corneal surgery and in that said selected group of people is a group of people who have undergone corneal surgery.

116. A multifocal intraocular lens according to any one of the claims 105 - 115, characterized in that said selected group of people is a group of people who will undergo a cataract surgical operation.

117. A multifocal intraocular lens according to claim 109 or 110 characterized in that the nonspherical surface is a modified conoid surface having a conical constant (cc) less than zero.

118. An multifocal intraocular according to claim 117 characterized in that it, for at least one of the foci, is capable of eliminating or substantially reducing spherical aberration of a wavefront in the eye or in an eye model arriving from a prolate surface having the formula:

$$z = \frac{(1/R)r^2}{1+\sqrt{1-(\frac{1}{R})^2(\mathbf{cc}+1)r^2}} + \mathbf{ad}r^4 + \mathbf{ae}r^6$$

the conical constant cc has a value ranging between –1 and 0,
R is the central corneal radius and
ad and ae are aspheric constants.

119. A multifocal intraocular lens according to any one of the claims 109 - 118, characterized in that one of the at least one nonspherical surface of the lens is the anterior surface.

120. A multifocal intraocular lens according to any one of the claims 109 - 118, characterized in that one of the at least one nonspherical surface of the lens is the posterior surface.

121. A multifocal intraocular lens according to any of the claims 104 - 120, characterized in that the reduction of aberrations is optimized for one of the foci.

122. A multifocal intraocular lens according to claim 121, characterized in that the reduction of aberrations is optimized for the base focus.

123. A multifocal intraocular lens according to claim 121, characterized in that the reduction of aberrations is optimized for one of the at least one additional focus.

124. A multifocal intraocular lens according to any of the claims 104 to 120, characterized in that the reduction of aberrations is optimized for the base focus and the at least one additional focus, simultaneously.

125. A multifocal intraocular lens according to any of the claims 104 to 124, characterized in that it is of diffractive type.

126. A multifocal intraocular lens according to claim 125, characterized in that the diffractive pattern is formed on the anterior and/or posterior surface of the lens.

127. A multifocal intraocular lens according to claim 125, characterized in that the diffractive pattern is formed on the lens surface that is modelled to reduce aberrations of the optical system.

128. A multifocal intraocular lens according to claim 125, characterized in that the diffractive pattern is formed on one surface of the lens and the other surface of the lens is modelled to reduce aberrations of the optical system.

129. A multifocal intraocular lens according to any of the claims 104 to 124, characterized in that it is of refractive type with annular rings with different radii of curvatures.

130. A multifocal intraocular lens according to claim 129 characterized in that the annular rings are formed on the lens surface that is modelled to reduce aberrations of the optical system.

131. A multifocal intraocular lens according to claim 129 characterized in that the annular rings are formed on one surface of the lens and the other surface is modelled

to reduce aberrations of the optical system.

132. A multifocal intraocular lens according to any of the claims 104 to 131, characterized in that it is bifocal.

133. A multifocal intraocular lens according to any one of the claims 104 to 132, characterized in that the lens is made from a soft biocompatible material.

134. A multifocal intraocular lens according to any one of the claims 104 to 133, characterized in that the lens is made of a silicone material.

135. A multifocal intraocular lens according to claim 134, characterized in that the silicone material is characterized by a refractive index larger than or equal to 1.43 at a wavelength of 546 nm, an elongation of at least 350 %, a tensile strength of at least 300 psi and a shore hardness of about 30 as measured with a Shore Type A Durometer.

136. A multifocal intraocular lens according to any one of the claims 104 to 133,, characterized in that the lens is made of hydrogel.

137. A multifocal intraocular lens according to any one of the claims 104 to 132,, characterized in that the lens is made of a rigid biocompatible material.

138. A multifocal intraocular lens according to any one of the claims 104 to 137,, characterized in that it is designed to balance the spherical aberration of a cornea that has a Zernike polynomial coefficient representing spherical aberration of the wavefront aberration with a value in the interval from 0.0000698 mm to 0.000871 mm for a 3 mm aperture radius.

139. A multifocal intraocular lens according to any one of the claims 104 to 137, characterized in that it is designed to balance the spherical aberration of a cornea that has a Zernike polynomial coefficient representing spherical aberration of the

wavefront aberration with a value in the interval from 0.0000161 mm to 0.000200 mm for a 2 mm aperture radius.

140. A multifocal intraocular lens according to any one of the claims 104 to 137, characterized in that it is designed to balance the spherical aberration of a cornea that has a Zernike polynomial coefficient representing spherical aberration of the wavefront aberration with a value in the interval from 0.0000465 mm to 0.000419 mm for a 2,5 mm aperture radius.

141. A multifocal intraocular lens according to any one of the claims 104 to 137, characterized in that it is designed to balance the spherical aberration of a cornea that has a Zernike polynomial coefficient representing spherical aberration of the wavefront aberration with a value in the interval from 0.0000868 mm to 0.00163 mm for a 3,5 mm aperture radius.

142. A multifocal intraocular lens according to any one of the claims 104 to 141, characterized in that it is designed to provide substantially the same reduced aberrations for all foci.

143. A multifocal intraocular lens according to any one of the claims 104 to 142 characterized in that the sum of the modulation for the two or more foci is more than 0.40, at a spatial frequency of 50 cycles per millimetre, when measured performed in an average/individual eye model using a 5mm aperture.

144. A multifocal intraocular lens according to claim 143 characterized in that the sum of the modulation for the two or more foci is more than 0.50.

145. A multifocal intraocular lens according to claim 143 or 144, characterized in that it is bifocal with a light distribution of 50-50% between the two foci having a modulation of at least 0.2 for each focus.

146. A multifocal lens according to any of claims 126 to 145 that is bifocal having a light distribution other than 50-50% obtained from reducing the step height of the diffractive pattern in the direction towards the lens periphery, so more light intensity is shifted to the distant focus than the near focus.

147. A multifocal lens according to claim 146 having a gradually reduced step height towards the lens periphery.

148. A multifocal lens according to claim 147 having a zone wherein the step height gradually reduces towards the lens periphery.

149. A multifocal lens according to claim 148 wherein said zone is located in the lens periphery.

150. A multifocal lens according to any of claims 102 or 103 to 149 characterized in that it comprises at least one surface configured to compensate a passing wavefront from chromatic aberration as introduced by the optical surfaces of the eye and the lens itself, so chromatic aberration is reduced for at least one of the foci comprising said multifocal lens.

151. A refractive multifocal lens according to claim 150 characterized in that said at least one surface is configured as a diffractive part with a diffractive surface pattern and has a refractive power to be added to the total lens power.

152. A multifocal lens according to claim 150 having a first diffractive pattern capable of generating multiple foci, wherein said surface is configured as diffractive part with a second diffractive surface pattern and has a refractive power to be added to the total lens power.

153. A multifocal lens according claim 152, that is a bifocal lens, wherein the second diffractive surface pattern consists of a number rings of which the first zone has a radial width of 1.5 mm for 20D total lens power.

154. A multifocal lens according to claim 152 or 153, wherein the second diffractive surface pattern is located on the anterior side of lens.

155. A multifocal lens according to claims 150 to 154 that is bifocal and has a correction for chromatic aberration that is balanced between the two foci in a manner that polychromatic modulation transfer functions at 50 cycles/mm obtained from a set eye model approaches the same value.

156. A multifocal lens according to claim 103 characterized in that it has at least one nonspherical surface construed so it reduces such aberrations in a wavefront passing said lens that are generated from the lens itself.

157. A multifocal lens according to claim 156 characterized in that it reduces spherical aberrration.

158. A multifocal lens according to claim 156 and 157 characterized in that is of the diffractive type having a diffractive pattern on the lens surface that is capable of generating multiple foci.

159. A multifocal lens according to claims 158 characterized in that it is a bifocal lens that distributes more light to its distant focus than to its near focus.

160. A multifocal ophthalmic lens having at least one nonspherical surface which when expressed as a linear combination of polynomial terms representing its aberrations is capable of reducing similar such aberration terms obtained in a wavefront having passed the cornea, thereby obtaining an eye sufficiently free from

aberrations.

161. A lens according to claim 160, wherein said nonspherical surface is the anterior surface of the lens.

162. A lens according to claim 161, wherein said nonspherical surface is the posterior surface of the lens.

163. A lens according to any one of the claims 160 to 162, being a multifocal intraocular lens.

164. A lens according to any one of the claims 160 to 163, wherein said polynomial terms are Zernike polynomials.

165. A lens according to claim 164 capable of reducing polynomial terms representing spherical aberrations and astigmatism.

166. A lens according to claim 165, capable of reducing the 11th Zernike polynomial term of the 4th order.

167. A lens according to any one of the claims 160 to 166 made from a soft biocompatible material.

168. A lens according to claim 167 made of silicone.

169. A lens according to claim 167 made of hydrogel.

170. A lens according any one of the claims 160 to 166 made of a rigid biocompatible material.

171. Multifocal intraocular lens according to any of the claims 104 to 170, characterized in that it is a bifocal intraocular lens of diffractive type with a

nonspherical anterior surface, and a diffractive pattern formed on the posterior surface.

172. Multifocal intraocular lens according to claim 171 characterized in that it has a light distribution of 50-50% between the two foci.

173. Multifocal intraocular lens according to claim 171 characterized in that it has a light distribution of 60-40% between the two foci.

174. Multifocal intraocular lens according to claim 171 characterized in that it has a light distribution of 40-60% between the two foci.